

*On the Spectra of Comets b and c, 1881, observed at the Royal Observatory, Greenwich.*

(Communicated by the Astronomer Royal.)

Comet b, 1881.

1881, *June 24*,  $8\frac{1}{2}^{\text{h}}$ – $13\frac{1}{2}^{\text{h}}$ .—The spectrum of Comet b was first examined on the evening of June 24, with the half-prism spectroscope mounted on the Great Equatoreal. The spectroscope was used in the “direct” position, as for the measures of displacement of lines in stellar spectra—*i.e.* with the light incident on that face of the “half-prism” which is perpendicular to the base. One half-prism was employed giving a dispersion of  $18^{\circ}$  from A to H, and a magnifying power of 14 was used on the viewing telescope. With this dispersion the spectrum from the nucleus and adjacent parts of the head appeared to be perfectly continuous, and only one band, in the green, was made out with certainty. This band was very distinct from one part of the head, but hardly traceable from any other part. Comparison with the second spectrum of carbon as given by alcohol vapour in a vacuum-tube showed that this band was situated at a distance of about 38 tenth-metres to the blue from the carbon-band at 5197 tenth-metres. Observer, W. C.

1881, *June 25*,  $9\frac{1}{2}^{\text{h}}$ – $14^{\text{h}}$ .—With the spectroscope in the same position as on the previous evening, three bands were now detected in the Comet’s spectrum, though the great brilliancy of the continuous spectrum nearly overpowered them, and rendered their observation a matter of difficulty. As far as could be judged, these bands were not obtained from the nucleus, but from its immediate vicinity. A comparison with the spectrum of cyanogen given by a vacuum-tube showed no instances of coincidence; but each of the three bands was seen to be coincident with the corresponding band of the spectrum of a Bunsen-flame at 5164, 4736, and 4311 respectively. No band was detected in the yellow. Observers, W. C. and M.

1881, *June 29*,  $10^{\text{h}}$ – $14\frac{1}{2}^{\text{h}}$ .—The bright bands had been isolated with such difficulty on June 24 and 25 that on this occasion the spectroscope was used as in the observations of prominences and reversed so as to give great purity of spectrum. The dispersion from A to H in this position is  $5^{\circ}$ , and the magnifying power 28. The continuous spectrum was given from a much smaller area of the Comet than on the two former nights of observations, being only  $15''$  to  $18''$  in breadth, and seen only over the nucleus and its immediate neighbourhood. Several dark lines were perceived in it, between the green and blue bands, one of these lines being undoubtedly F. The *b* lines could not be made out, but they would fall just within the bright edge of the green band.

Three bright bands were seen, yellow, green, and blue, the

band in the violet not being detected. Each band was bright and fairly sharp towards the red, and became gradually fainter towards the blue end of the spectrum. They were seen bright on the bright background of the continuous spectrum from the head, but could not be traced across the nucleus. The dark lines could not be detected in the spectrum of the nucleus, but this may have been due to its being so very narrow (2'' or 3'' in breadth).

The comparative brightness of the three bands was as follows :—

Yellow band	...	3	Edge not very sharp.
Green band	...	10	Edge sharp and distinct.
Blue band	...	1	Edge sharp.

The green band was obtained from the whole of the head, and for 12' from the nucleus down the tail.

The single-prism spectroscope was now substituted for the other for a few minutes, and the exact coincidence of the three comet-bands with the three of the Bunsen-flame noticed, the accord when the two spectra were seen side by side being as perfect in every way as the eye could judge. This spectroscope did not show the violet band, but the blue band appeared much brighter in comparison with the other two than with the half-prism spectroscope. It was estimated as brighter than the yellow band, and as quite half as bright as the green.

No dark lines were distinguished in the continuous spectrum above the green band, but several strong lines were seen below it. Daylight came on before measures of these lines could be obtained, but rough estimations of their positions showed that two of the darkest were probably the E group, and the strong double line at 5327. The D lines were not made out with certainty. Observer, M.

The half-prism spectroscope reversed, with one half-prism, as in the earlier part of the evening of June 29 was used for all the subsequent observations both of this Comet and of Comet c (Schäberle's).

1881, *July 2, 12<sup>h</sup>*.—The continuous spectrum was faint, and no dark lines were detected in it. The green band of the Comet was seen to be perfectly coincident with the band from the Bunsen-flame. Clouds prevented further observation. Observer, M.

1881, *July 4, 10<sup>h</sup>–14<sup>h</sup>*.—The three bands, yellow, green and blue, were seen as usual, the first and last being very faint. No others were detected. The continuous spectrum was too narrow to show any dark lines. Observer, M.

1881, *July 6, 10<sup>h</sup>–14<sup>h</sup>*.—The continuous spectrum was more distinct than on July 4, but no dark lines could be detected.

With the spectra of the Comet and of the Bunsen-flame

arranged one above the other, and the flame adjusted until the bright sharp edge of the green band was of the same intensity in each, the resemblance between the two spectra was exceedingly striking, the three principal bands corresponding exactly in position, in brightness, and in the manner and degree in which they shaded off towards the violet. The fourth band (that in the violet) was, however, far less distinct in the Comet spectrum than in that of the Bunsen-flame—indeed, its presence in the former was only just suspected. Search was also made for a red band and with a very wide slit an extremely faint light was just suspected somewhere in the red part of the spectrum about midway between C and D. Observer, M.

The following are the determinations of the wave-lengths of the less refrangible edges of the three principal bands.

Yellow Band.

Date.	Observer.	Spectroscope.	Compared with	Width of Wave-Length Slit. of Comet-band.	
				tenth-metr.	tenth-metr.
June 29	M.	Half prism, reversed	Marsh gas	13·1	5627·0
		" "	"	13·1	39·5
		" "	"	13·1	19·4
July 6	M.	" "	Bunsen-flame	16·8	32·4
		" "	"	16·8	29·5
		" "	"	16·8	29·9
		" "	"	16·8	35·0
		MEAN		5630·4 ± 1·6	

Green Band.

June 24	W. C.	Half prism, direct	Alcohol	62·1	5151·7*
		" "	"	62·1	59·8
25	M.	" "	Cyanogen	9·7	67·9
		" "	"	9·7	59·0
		" "	"	9·7	61·5
29	M.	Half prism, reversed	Marsh gas	9·6	59·9
		" "	"	9·6	61·8
		" "	"	9·6	60·9
		Single prism	Bunsen-flame	26·1	61·5
		"	"	26·1	65·0
July 4	M.	Half prism, reversed	"	14·7	65·3
		" "	"	14·7	63·7
		" "	"	5·4	58·1
		" "	"	5·4	61·9
		" "	"	5·4	65·0

\* Measure rough.

Date.	Observer.	Spectroscope.	Compared with	Width of Slit.	Wave-Length of Comet-band.
July 6	M.	Half prism, reversed	Bunsen-flame	tenth-metr. 3·6	tenth-metr. 63·8
		" "	"	3·6	64·0
		" "	"	3·6	64·0
		" "	"	3·6	64·3
		" "	"	3·6	64·0
		" "	"	3·6	65·3
		" "	"	12·4	64·0
		" "	"	12·4	63·7
		" "	"	12·4	63·4
		" "	"	12·4	65·2
		" "	"	12·4	64·4
MEAN				5162·7 ± 0·4	

*Blue Band.*

June 29	M.	Half prism, reversed	Marsh gas	6·2	4728·2
		" "	"	6·2	30·2
July 6	M.	" "	Bunsen-flame	7·9	35·5
		" "	"	7·9	36·9
		" "	"	7·9	36·0
		" "	"	7·9	36·4
MEAN				4733·9 ± 1·1	

The following measures were also obtained of the dark line F seen in the continuous spectrum as compared with the H $\beta$  line from a vacuum-tube.

Date	Observer.	Spectroscope.	Width of Slit.	Wave-Length of Dark Line.	Apparent Displacement.
June 29	M.	Half prism, reversed	tenth-metr. 2·8	tenth-metr. 4860·92	tenth-metr. +0·18
		" "	2·8	60·42	-0·32

Thalén's wave-lengths for the less refrangible edges of the bands in the two spectra of the carbon compounds were assumed throughout, as follows :—

Band.			First Spectrum. Bunsen-flame.	Second Spectrum. Marsh Gas or Cyanogen.
			tenth-metr.	tenth-metr.
Yellow band	...	...	5633·0	5607·5
Green band	...	...	5164·0	5197·0
Blue band	...	...	4736·0	4697·0

Comet c 1881 (Schäberle's).

1881, Aug. 4, 8 $\frac{1}{2}$ <sup>h</sup>–13 $\frac{1}{2}$ <sup>h</sup>.—The Comet showed a spectrum consisting of three bright bands approximately coincident with the

C

three brightest bands of the spectrum of the Bunsen-flame. Eventually a very faint continuous spectrum, due to the nucleus, was detected. The green band was the only one which had a sufficiently defined edge to be measured. The yellow band appeared to be displaced towards the blue of the corresponding band of the flame spectrum by a small but unmistakeable distance—say about 8 tenth-metres. The blue band was too faint for anything to be observed concerning it further than that it showed a rough coincidence with the band from the Bunsen-flame. The whole of the head of the Comet gave the spectrum of the bands.

The relative brightness of the bands appeared to be as follows:—

Yellow band	...	...	3
Green band	...	...	10
Blue band	...	...	1

Observer, M.

1881, *Aug.* 6,  $8\frac{1}{2}^h$ – $13^h$ .—The Comet's spectrum showed no change since August 4, except that it now seemed very faint, owing to the brilliant moonlight. The nucleus still gave a faint continuous spectrum, traceable from about D to F, but the spectrum of the bands was many times as bright. The whole of the head of the Comet gave the green band, but it could not be detected over the tail. The blue band was seen, but was not measurable, and no new bands could be discerned in the red, orange or violet. A narrow slit was employed on the green band, but it could not be resolved into lines. Observer, M.

1881, *Aug.* 19,  $8^h$ – $11\frac{1}{2}^h$ .—The three bands were seen as on the two previous occasions, and with a very wide slit two others were suspected, the one as far below D as the yellow band is above it—that is to say, in the neighbourhood of wave-length  $6200 \pm$  tenth-metres—and the other just to the red of G or at wave-length  $4310 \pm$ . The continuous spectrum was now obtained not merely from the nucleus, but also from its immediate neighbourhood, and showed a total breadth of  $7''$ , and it was visible from the red band up to the one in the violet, but no dark lines could be detected in it. The band spectrum was, however, still many times as bright as the continuous spectrum from the nucleus, at the less refrangible edges of the principal bands. The green band was given by every part of the head, even the faintest, and was clearly obtained from the tail for quite  $10'$  from the nucleus. A very narrow slit was used on the green band in order to detect any resolvability if possible. The band could not be broken up into lines, but a second edge was suspected about  $5126$ . Observer, M.

The following measures were obtained of the positions of the less refrangible edges of the yellow and green bands. Of the

blue band it was only ascertained that it seemed to be coincident with the band of the Bunsen-flame at 4736.0. The half-prism spectroscope reversed was used throughout, and the comparisons were all made with the spectrum of a Bunsen-flame.

*Yellow Band.*

Date.	Observer.	Width of Slit.  tenth-metres.	Wave Length Comet Band.  tenth-metres.
1881, August 6	M.	33.9	5629.3
		33.9	36.3
		33.9	21.3
		33.9	33.9
		33.9	24.7
		MEAN	5629.1 ± 2.1

*Green Band.*

1881, August 4	M.	15.6	5162.8
		15.6	63.0
		15.6	63.3
		15.6	64.4
		6.3	65.7
		6.3	63.9
		6.3	62.8
		6.3	61.8
		6.3	64.3
		6.3	63.1
August 6	M.	6.4	62.6
		6.4	63.1
		6.4	63.3
		6.4	64.4
		6.4	64.5
		6.4	62.8
		6.4	64.0
		6.4	65.1
		6.4	63.4
		6.4	63.6
		MEAN	5163.6 ± 0.15

The initials W. C. and M. are those of Mr. Christie and Mr. Maunder respectively.

*Royal Observatory, Greenwich:*  
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